Projecting Effects of Climate Change on River Habitats and Salmonid Populations:

Integrating Remote Sensing, Genomics, and Demography to Inform Conservation

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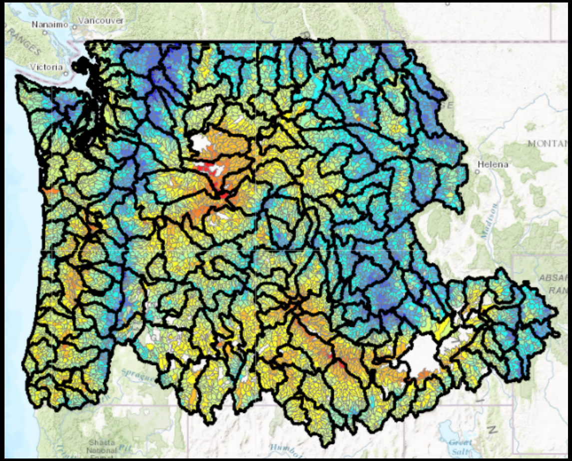


Urgent need for genomic monitoring and climate change assessments of salmonids

Urgent Need

- Salmonids are "canaries of climate change"
- Multi-millions spent annually on salmonid conservation
- Prioritization of populations for management needed

Clean, Connected, **COLD** Habitat

Spawning bull trout

Vulnerability to future climate depends on climate exposure, sensitivity & adaptive capacity.

Integrate as key elements of VULNERABILITY

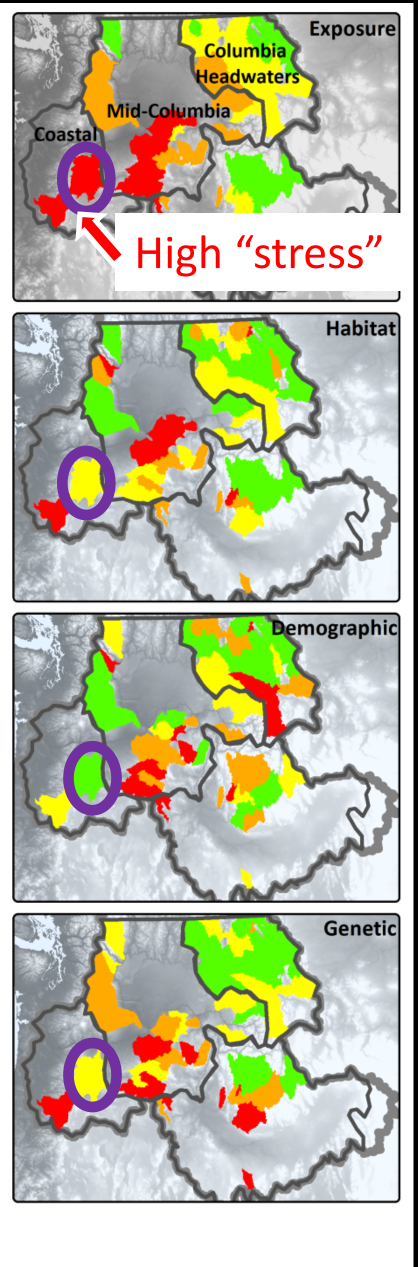
Exposure	Adaptive Capacity – rapid response	Sensitivity – physiological response
Habitat (Remotely Sensed)	**Genomics**	**Demographics**
Climate	Number of Effective Breeders	Abundance
Physical habitat characteristics	Genetic diversity	Life History Diversity
		Productivity

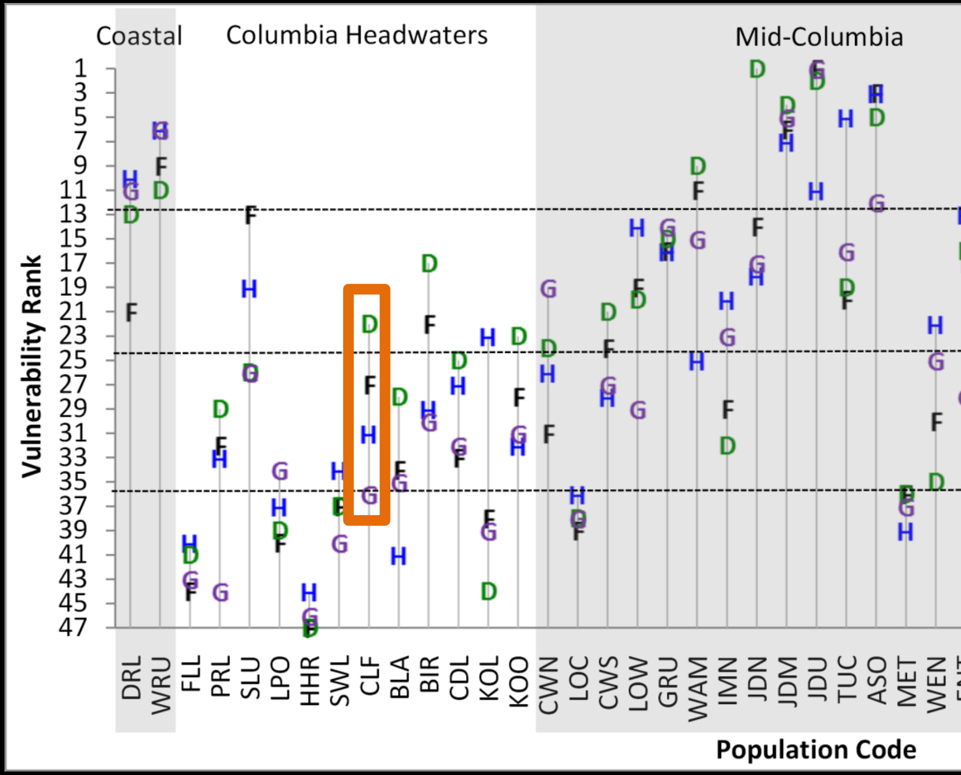
Climate Change Vulnerability Assessment: How does demography and genetic factors interact with environmental factors across populations?

An example from bull trout.

(Wade et al. 2016 with collaborators from the USGS)

A given population may have very different levels of "stress" depending on stressor type





A given population may be considered "relatively vulnerable" solely on the basis of the variables considered

How can we improve CCVAs?

Incorporating additional metrics into CCVAs and correlating with remote sensing data

Landscape Genetics/Genomics

Climate variables were correlated with genetic diversity in steelhead and bull trout genetic

(Hand et al. 2016; Kovach et al. 2015)

Demographic: productivity

Genetic: effective number of breeders (Nb)

Variation in Chinook population productivity is related to environmental conditions and habitat quality/quantity

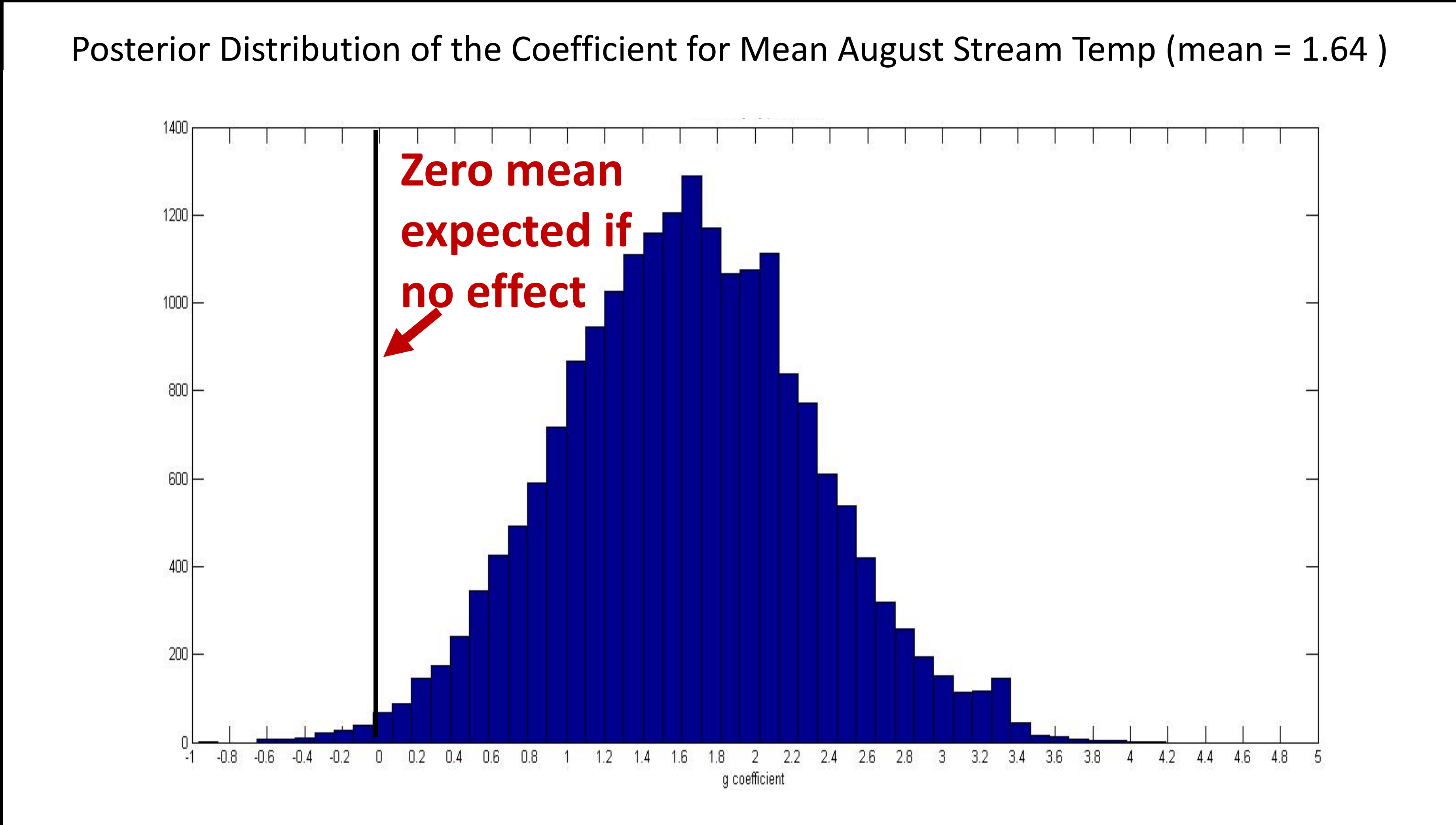
Nick Gayeski – NGO: Wild Fish Conservancy (in prep)

Used Bayesian inference to correlate productivity with environmental variables.

Productivity =Recruits/Adult Spawner
Long time series (~10-20 years) for 16 Chinook river basins

Environmental variables
- Stream temperature, floodplain area, the highest 5% winter flows, NPP, human disturbance

Chinook salmon population productivity (recruits/spawner) varies with stream temperature and NPP



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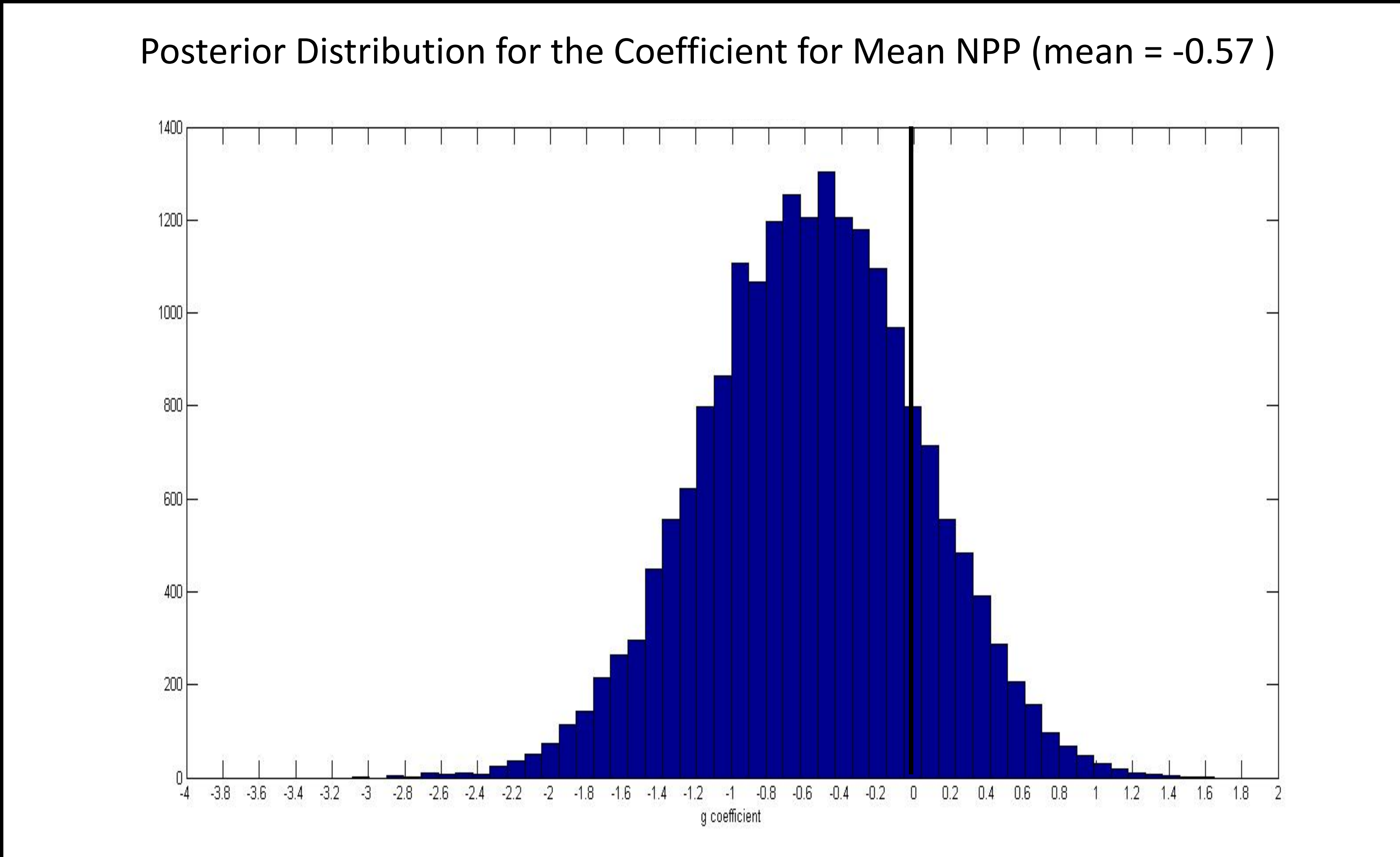
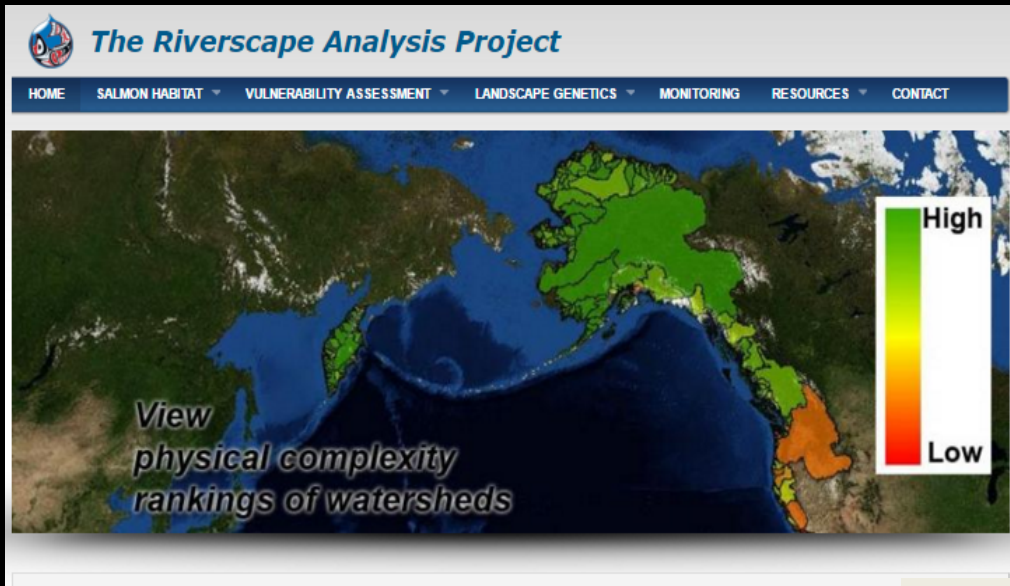


The Riverscape Analysis Project (RAP): An integrated platform for salmonid conservation



Web-based support tool for salmonid conservation

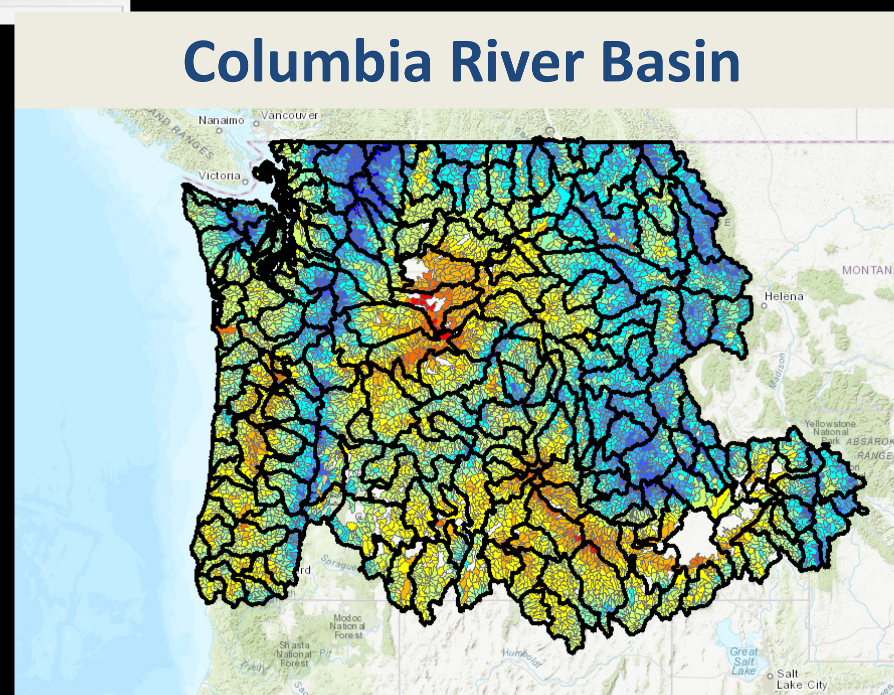
Basin scale data for the Pacific NW and fine scale (HUC 12) for the Columbia River Basin

Data

- Expanded access to remotely-sensed climate/habitat data

Tools

- Basic CCVA
- Demogenetic monitoring (Nb)
- Landscape genetic tools

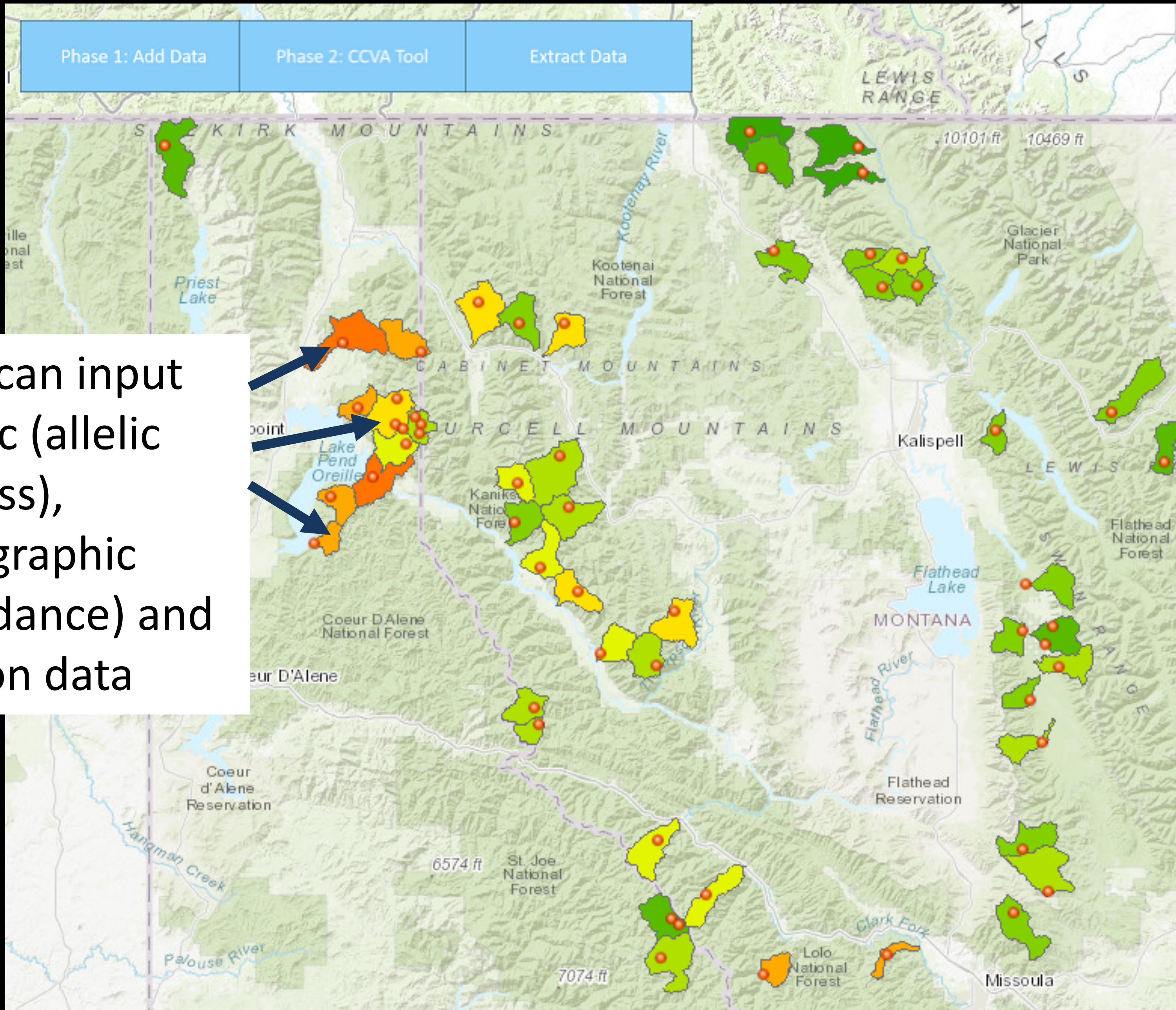


Increased Data Access to salmonid/aquatic habitat characteristics

Climate Data	RS Mission/ Product
Freeze-Thaw Timing	**NASA SSM/I, AMSR-E**
Open Water	**NASA AMSR-E**
NorWeST Stream Temperature	**NASA Landsat TM** & NAIP
USFS Stream Flow	n/a
Future predictions Air Temperature, Precipitation, Runoff	**NASA NEX-DCP 30**

Habitat Quality Data	RS Mission/ Product
Drainage Density, Amount, and Sinuosity	**NASA SRTM** & NHDPlusv2
Productivity	**NPP**
Disturbance: NOAA CHAMP, Human Footprint, and NLCD 2011	**NASA GRUMP, GPWv3, DMSP, Landsat** (Landcover - % disturbance and % forested)
Channel and Valley Slope	**NASA SRTM**
Others: Glaciers, Dams, Elevation, Waterbodies	various

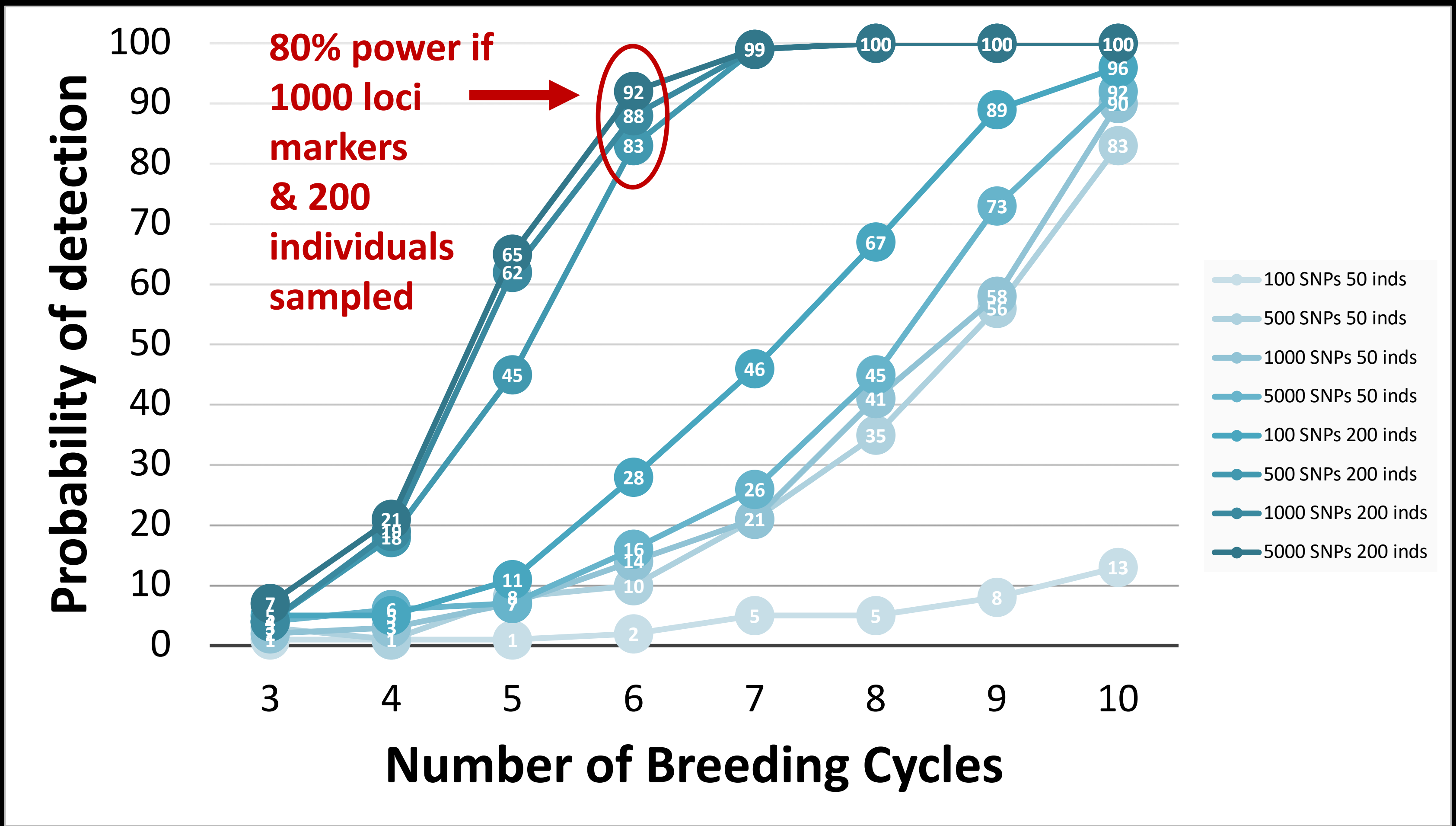
Climate Change Vulnerability Assessment Tool Available now on RAP



Users can input genetic (allelic richness), demographic (abundance) and location data

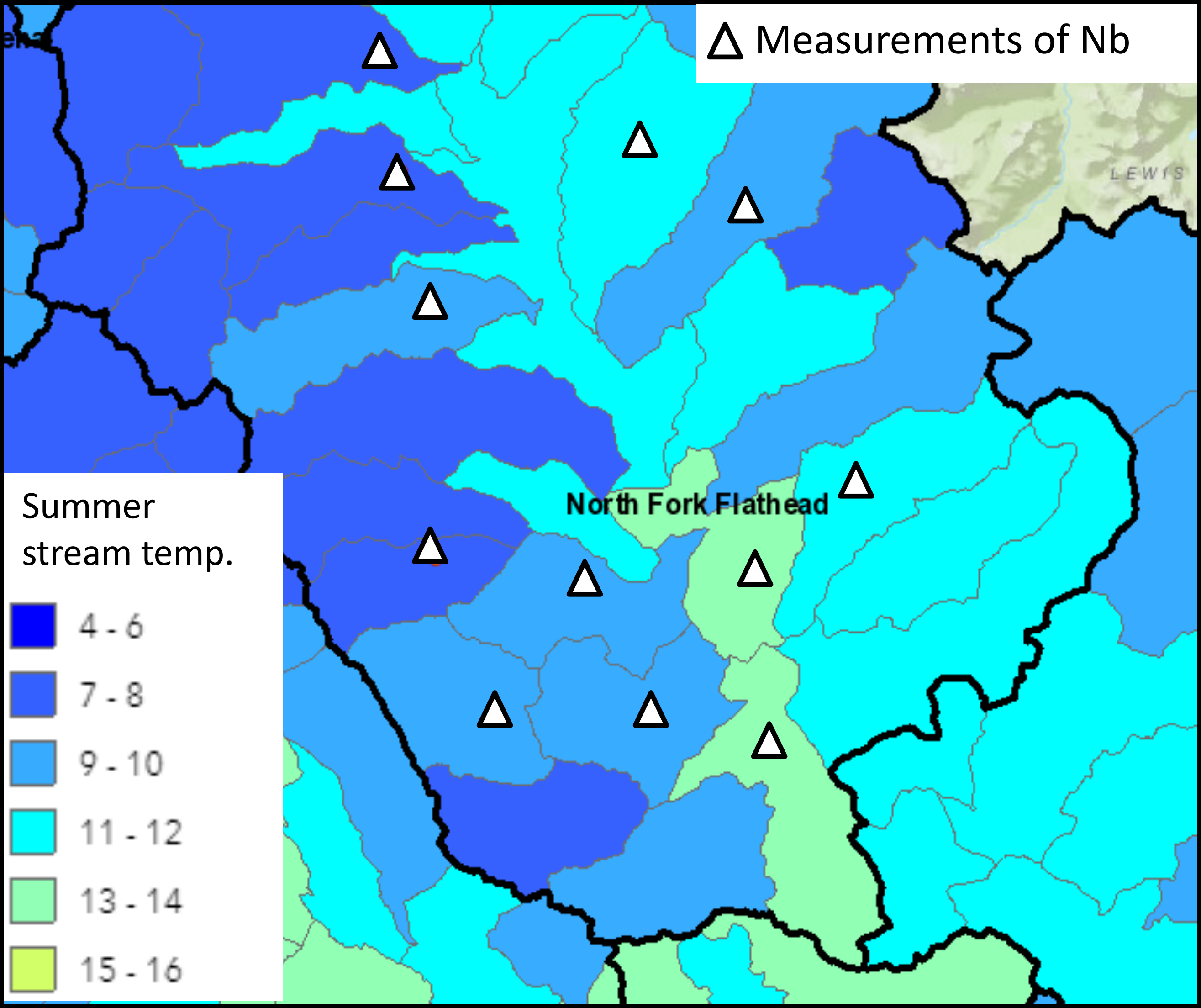
Answering the need for genomic monitoring tools related to abundance and genomic diversity: AgeStrucNe

Nb (number of breeders) provides an annual measure of abundance and genomic diversity, and is driven by environmental factors



Genomic Monitoring tools for resource managers: A tool for visualizing and correlating Nb to environmental variables

Coming Soon: Available through the RAP website



Advance training for project collaborators and conservation professionals

The course aims to provide training in conceptual and practical aspects of data analysis to understand the evolutionary and ecological genomics of natural and managed populations. Special section in this years course include landscape genomics, genomic monitoring tools for assessing the impacts of climate change and epigenomics.

For more information visit the website:
www.umt.edu/sell/cps/congen2018/
Or contact Brian Hand or Gordon Luikart
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Gordon.Luikart@umontana.edu

Thanks!

NASA

UNIVERSITY OF MONTANA
Flathead Lake Biological Station

Integrating remotely-sensed habitat quality and quantity, demographic, & genomic data

Integrating data, tools, & support (outreach) for salmonid conservation

pacific northwest aquatic monitoring partnership

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

IDAHO FISH & GAME

U.S. FISH & WILDLIFE SERVICE

Montana Fish, Wildlife & Parks

Columbia River Inter-Tribal Fish Commission

Wild Fish Conservancy NORTHWEST

USGS
science for a changing world